



---

# Cognitive Guidelines to Support Effective Collaboration

Presented to  
Collaboration and Knowledge Management Workshop

Team Members  
David Noble (PI), Cara Christie, Jim Yeargain, Stacey Lakind,  
Jim Richardson, and Steve Shaker

January 14, 2004

---

\* Phase 2 SBIR from Office of Naval Research

<b>Report Documentation Page</b>			<i>Form Approved OMB No. 0704-0188</i>	
<p>Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p>				
1. REPORT DATE <b>14 JAN 2004</b>	2. REPORT TYPE	3. DATES COVERED <b>00-00-2004 to 00-00-2004</b>		
4. TITLE AND SUBTITLE  <b>Cognitive Guidelines to Support Effective Collaboration</b>			5a. CONTRACT NUMBER	
			5b. GRANT NUMBER	
			5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)			5d. PROJECT NUMBER	
			5e. TASK NUMBER	
			5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Evidence Based Research Inc, 1595 Spring Hill Rd Ste 250, Vienna, VA, 22182</b>			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)	
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>				
13. SUPPLEMENTARY NOTES <b>Collaboration and Knowledge Management (CKM) Workshop, 13-15 Jan 2004, San Diego, CA. U.S. Government or Federal Rights License</b>				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>28</b>
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>	19a. NAME OF RESPONSIBLE PERSON	



# Project Summary

- Objectives
  - Synthesize cognitive theory of collaboration
  - Articulate critical knowledge for successful collaboration
  - Develop cognitive-based collaboration metrics
  - Apply theory to help teams collaborate more effectively (focus of this presentation)
- Research Questions
  - Critical knowledge for effective collaboration
  - Means to package awareness of critical knowledge to improve collaboration
  - Means to leverage cognitive framework to identify collaboration metrics
- Project Status
  - Third and final year of project
  - Metrics summarized in handbook “Command Center Performance Assessment System”
  - Five teams have tried out the Collaboration Advizor tool. All agreed it provided appropriate diagnosis, that its recommendations were useful, and that it helped teams surface and discuss critical issues
  - Formal evaluation planned at Navair in February
  - Commercial version of tool under development
  - Metrics and tool transitions on track



# Topics

---

- Why teams fail
- Project goals
- Theory
- Diagnosis and recommendation tool
- Chronology, validation, publications, and transitions
- Summary



# Why Teams Fail

---

- Physical causes
  - The goal is too hard for any team to achieve, given the available resources
- Cognitive causes
  - The goal is not too hard to achieve, but the team doesn't know how to achieve it
- Social causes
  - The goal is not too hard to achieve and the team knows how to achieve it, but team members are not willing to work hard enough



# Examples: Team Failures for Cognitive Reasons

## The Bay of Pigs, 1962

A talented and intelligent policy team, but Groupthink doomed the team to an unworkable plan with disastrous results



## The Iranian airline shootdown, July 3, 1988

Well trained team on Vincennes, but misunderstandings of each others information and perspectives led to a tragic mistake



# Goals

## Help Teams Do Well Cognitively

- Problems
  - There's a morass of cognitive factors
  - It's hard to understand cognitive factors
  - It's hard to diagnose specific problems
  - It's hard to determine effective means to address the problems
- Approach
  - Synthesize cognitive theory of collaboration
  - Organize cognitive issues to help teams understand them (e.g., create periodic table of cognitive factors)
  - Create a tool to help team members diagnose problems and identify remedies
  - Validate tool effectiveness
  - Explain and publicize cognitive team issues



# Theory

---

- Basic premises
- Collaboration building blocks
- The twelve enablers



# Premises

## Knowledge Basis for Collaboration

- Knowledge is central to collaboration and teamwork
  - Teams whose members know what they need to know can work together effectively. Those that do not are prone to various kinds of predictable errors, with the type of error dependent on the type of knowledge deficiency
- Knowledge must be distributed among members of a team
  - Everybody does not need to know everything for a team to be effective. But every team member does need to know how to get the knowledge he or she needs.
- Individuals need to know about both “taskwork” and teamwork
  - Taskwork knowledge is what team members need to carry out their tasks were they acting alone
  - Teamwork knowledge is what team members need to know to work together effectively
- The collaborative dialog helps generate the needed teamwork and taskwork knowledge
  - Team members exchange ideas to clarify issues and reach consensus to put in place the knowledge and understandings that team members must have to achieve the team’s mission.



# Theory: How Teams Work

## Building Blocks of Collaboration and Teamwork

### Team Set Up and Adjustment

- Form team
- Review goals
- Identify tasks
- Determine roles

Need for changes  
Team set up

### Group Problem Solving

- Brainstorm
- Prioritize
- Discover differences
- Enrich
- Reach consensus

Issues to work on  
Discussion results

### Synchronize and Act

- Mass effects
- Lay groundwork
- Hand off tasks
- Backup
- Cue to situation

Performance feedback  
What to do next

### Individual and Shared Understandings

- About plan, goals, tasks, and situation
- About team members backgrounds, activities, and status
- About task and team status and prospects



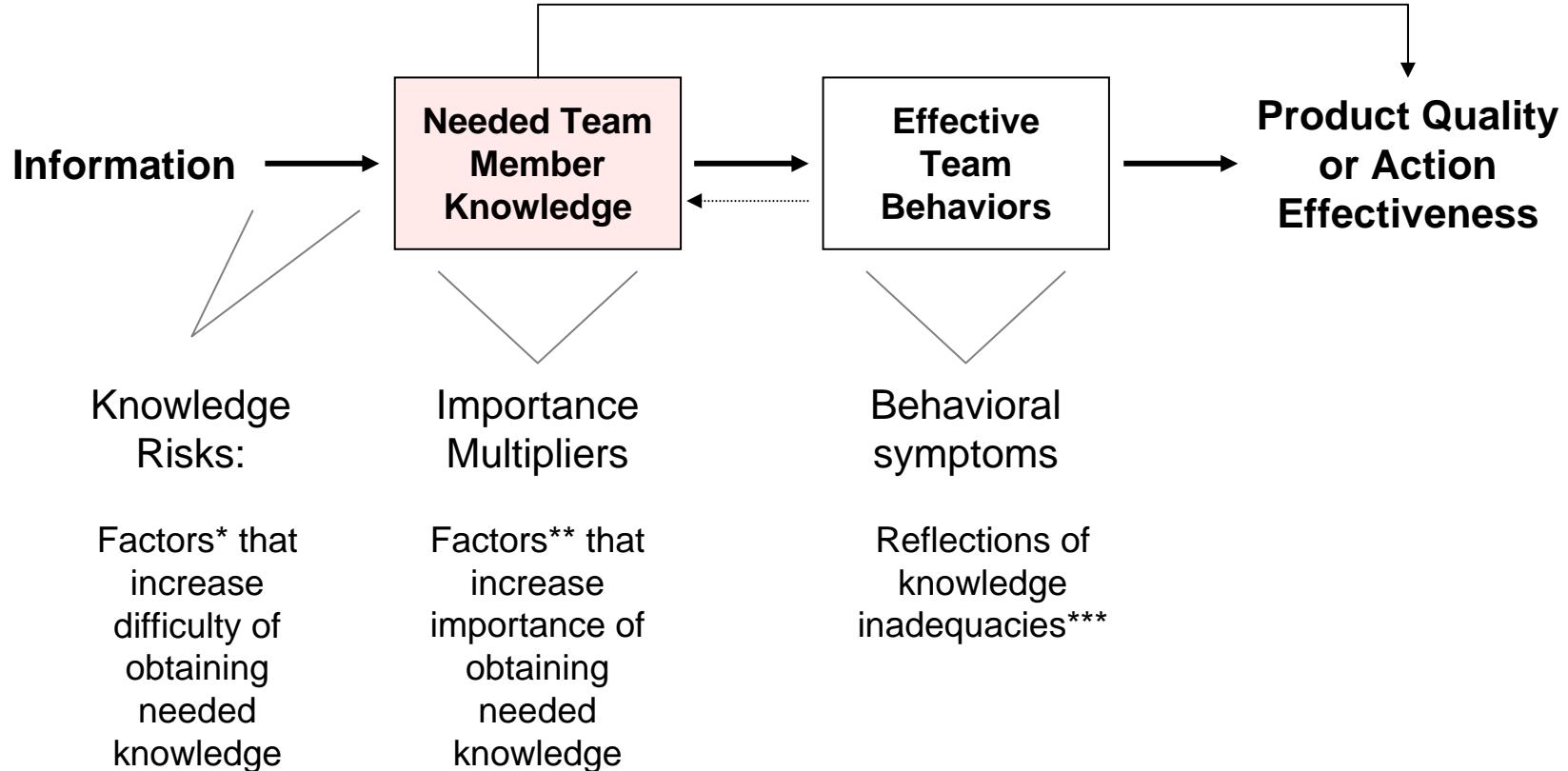
# Group Problem Solving

## Sharing of Perspectives

- Collaboration enables teams to “make better lists”
  - Better views on what is happening, the reasons for these occurrences, and their impacts on the team mission
  - Better set of candidate actions to take in response to these impacts
  - Better set of criteria to consider when evaluating the desirability of these actions
  - Better estimates of possible consequences of the alternatives being considered



# Information to Product



\*asynchronous, geographically distributed, cultural diversity, heterogeneous knowledge, unique roles, task dependencies, rotating team members

\*\*highly interdependent tasks, poor management support, intelligent adversary, dynamic environment

\*\*\*missed deadlines, failure to offer help, surprise at others behaviors, failure to share information, redundant or missed tasks



# The Twelve Enablers

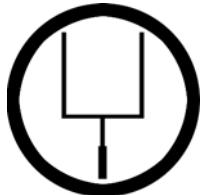
---

- Represents basic cognitive foundations for effective collaboration
- At a level useful for diagnosis and recommendations
  - Deficiencies in enablers are the underlying causes of teamwork problems
  - Risks and symptoms map easily to enablers
  - Recommendations follow directly from them
- Generalizes well known critical C2 and decision functions for teams



# Knowledge Enablers

## Foundational Knowledge



Goals



Others



Plans



Business rules



Dependencies

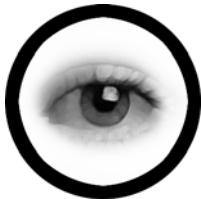


Task skills



# Knowledge Enablers

## Real Time Understanding and Assessments



Activity Awareness



Mutual Understanding



External Situation



Plan Prospects



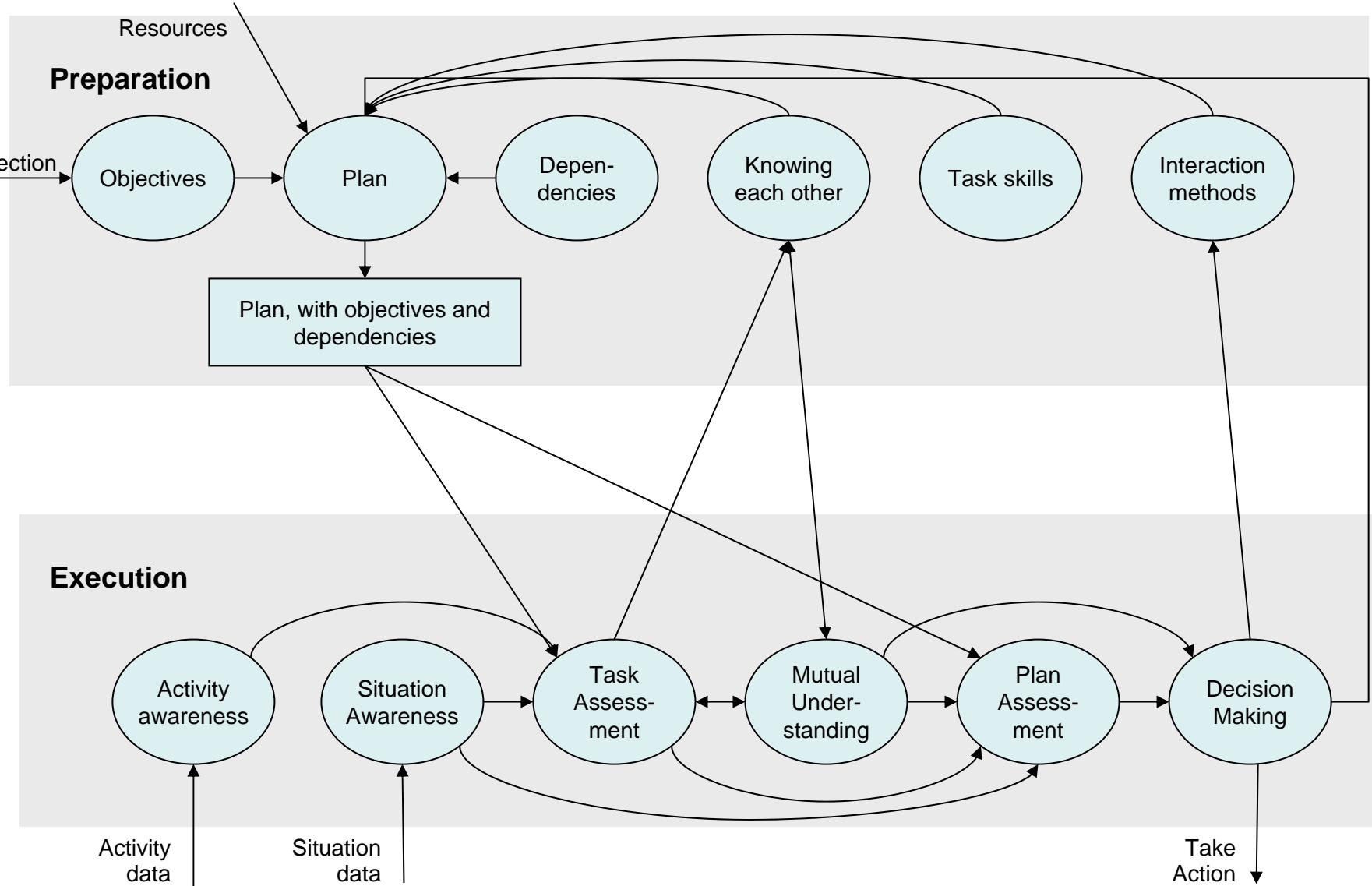
Task Progress



Decision Factors



# Principal Enabler Dependencies



# Diagnosis and Recommendation Tool

- Expert system software
  - Educates
  - Alerts to possible knowledge problems
  - Warns of consequences
  - Shows areas of agreement/disagreement
  - Suggests ways to improve





# Tool Modes

---

- Individual mode
  - Asks questions about the team, task, and environment
  - Collects answers
  - Evaluates enablers that matter and are at risk or deficient
  - Helps people explore issues individually
- Team view
  - Assembles answers
  - Shows areas of agreement and disagreement
  - Provides safe discussion forum
- Trends view
  - Changes in team knowledge enablers over time, with critical events superimposed
  - Changes to risks and symptoms responsible for enabler changes



---

# Storyboard for Commercial Version to Tool

Upon completing use of the tool, the user will see a screen presenting several options:

**Team View**

**Trend View**

**Individual View**

**Select Date**

v

**September 2003**

**October 2003**

**November 2003**

**December 2003**

**January 2004**

**February 2004**

# TEAM RESULTS

MOST RECENT TESTING - NOV. 28, 2003  
NUMBER OF TEAM MEMBERS - 15

Enablers

Questions

Recommend

Help

Return to Menu

## Enabler Areas of Concern

Knowledge Strength		Description:
	weak	strong
<ul style="list-style-type: none"><li> Goals</li><li> Planning</li><li> Dependencies</li><li> Each Other</li><li> Business Rules</li><li> Task Skills</li><li> Activity Awareness</li><li> External Situation</li><li> Task Progress</li><li> Mutual Understanding</li><li> Plan Assessment</li><li> Decision Factors</li></ul>	<p><b>Description of Planning</b></p> <p>This is the overall understanding of the plan, which should define tasks, assign those tasks to team members, and specify a work schedule.</p> <p>Plans should also outline leadership roles, identify individuals as subject matter experts, and clarify who is responsible for a task and who will support that person's efforts.</p> <p>Click to close</p>	<p><b>Description:</b></p> <p>It is important to understand the team's roles, tasks, schedules, resources, and criteria for success. <a href="#">[ more ]</a></p> <p><b>Consequences:</b></p> <p>When teams are weak in Planning, team members may work on others' tasks or neglect their own tasks. <a href="#">[ more ]</a></p> <p><b>Symptoms:</b></p> <ul style="list-style-type: none"><li>1. Disagreement over responsibilities.</li><li>2. Incomplete or missing tasks.</li><li>3. Inconsistent efforts. <a href="#">[ more ]</a></li></ul> <p><b>Recommendations:</b></p> <ul style="list-style-type: none"><li>1. Develop a complex project plan.</li><li>2. Define clear roles and responsibilities.</li><li>3. Too many team members. <a href="#">[ more ]</a></li></ul>

 - requires immediate attention

 - requires monitoring

 - acceptable

Go to Details

Print Screen

# TEAM RESULTS

MOST RECENT TESTING - NOV. 28, 2003  
NUMBER OF TEAM MEMBERS - 15

[Enablers](#)[Questions](#)[Recommend](#)[Help](#)[Return to Menu](#)

**Questions for:** Enabler - Planning

 High Agreement: There is a problem.  
 Poor Agreement: There may be a problem.  
 High Agreement: There is not a problem.

Questions	All	V	Agree	Disagree	Enablers	Planning	V	Recommendation
1. The team roles and responsibilities goals.			 	 		<input type="checkbox"/> All		the team's goals and products. <a href="#">[ more ]</a>
2. The team never double checks to make sure that all team members understand and support the						<input type="checkbox"/> Goals		ditions for success.
3. The team never clearly defined member roles and task responsibilities.						<input type="checkbox"/> Planning		requirements. <a href="#">[ more ]</a>
4. The team never clearly specified and documented the schedule, including task deadlines and intermediate milestones.						<input type="checkbox"/> Dependencies		customers. <a href="#">[ more ]</a>
5. Team members do not know what resources have been assigned to tasks.			4	1	Planning	<input type="checkbox"/> Each Other		Describe necessary tasks. <a href="#">[ more ]</a>

## Recommendation

1. Articulate the team's goals, desired products, and how to achieve both.
2. Diagram the tasks that support common goals and that occur together or sequentially.
3. Create a timeline of task milestones.
4. Create a workflow chart that describes tasks, dependencies, resource needs, and individual assignments.

Click to close

[More Results](#)[Print Screen](#)

# TRENDS OVER TIME

TESTING DATES - SEPT '03 THRU JAN '04  
NUMBER OF TEAM MEMBERS - 15

Enablers

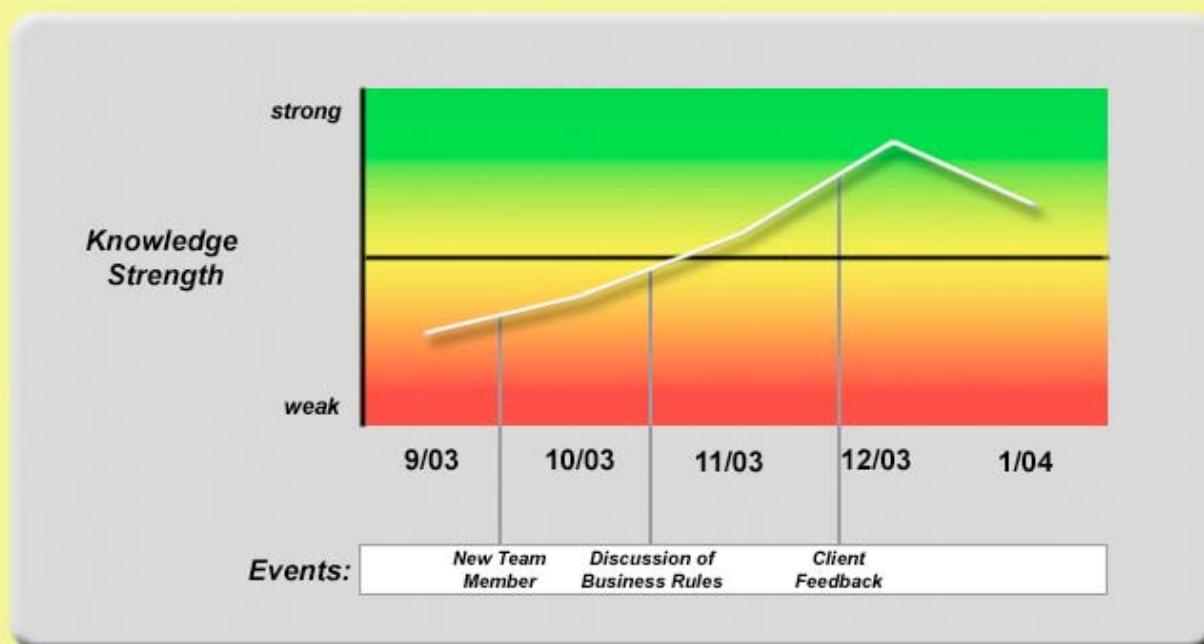
Questions

Help

[Return to Menu](#)

## Trends of Knowledge Strength Over Time

-  Goals
-  Planning
-  Dependencies
-  Each Other
-  Business Rules
-  Task Skills
-  Activity Awareness
-  External Situation
-  Task Progress
-  Mutual Understanding
-  Plan Assessment
-  Decision Factors



[View All Enablers](#)

[View the Most Improved](#)

[View the Least Improved](#)

This is a composite view of the team's progress in terms of the **Planning** Enabler. This composite integrates all of the data from the team's input on questions related to **Planning**.

[Go to Details](#)

[Print Screen](#)



# Development Chronology

---

- 2000 (Phase 1): Metrics, theories, taxonomies (with Klein)
- 2001 (Phase 2 begins): Case studies, initial enabler set, paper-based guidelines
- Fall 2002: Version 1. Medical diagnosis model, expert system framework, individual mode only
- Winter 2003: Version 2. War Room and CCRP team use, add team view, demo at Navy Opportunity Forum
- Summer 2003: Version 3. Improved question selection, with emphasis on exploring issues. NPGS team tryout. Define trend view
- Fall 2003: Version 4. Improved knowledge base increasing focus on education. UK team evaluation. Planned Navair evaluation. Tool patent submission
- Spring 2004. Commercial version



# Validation

---

- From existing literature
  - Consistency of theory, risks, and symptoms with academic and business management findings
- “Face value” validation of the tool
  - Five teams tried it out: EBR war room (six times) and CCRP teams, NPGS teams (twice), and two UK teams
  - Team feedback: diagnoses appropriate and helped identify real issues, useful recommendations
- Formal experiments
  - Piggy backing on Navair in February
  - Will test statistically if teams with tool do better than teams without the tool
  - Streamlined tool to focus on educational utility



# Lessons Learned

---

- Cognitive framework of twelve enablers makes sense to users
- Paper-based guidebook for diagnosis, discussion, and recommendations too hard to use.
- Expert system version easy to use. Users perceived diagnosis to be accurate and helpful
- Tool perceived to contribute in three ways
  - Educational: Informs users of critical knowledge and processes
  - Discussion: Provides a socially safe forum for raising issues
  - Recommendations: Provides good checklist
- Leaders may feel threatened by Advizor tool
- Tool cannot ignore social issues entirely, but it's risky to address too obviously and directly
- May need to tailor language and emphasis of tool for different types of teams



# Some Publications

- Conference Proceedings
  - “Cognitive-Based Metrics to Evaluate Collaboration Effectiveness.” SAS 039 Symposium: Analysis of Military Effectiveness of Future C2 Concepts and Systems, April 2002
  - Collaboration Advisor™ Diagnosing and Fixing Collaboration Problems Navy Opportunity Forum. May 2003
  - “Understanding and Applying the Cognitive Foundation of Effective Collaboration” 15<sup>th</sup> International Conference on Systems Research, Informative, and Cybernetics
  - “Objective Metrics For Evaluation of Collaborating Teams” 2003 Command and Control Research and Technology Symposium, Info (June 2003)
  - “Understanding and Applying the Cognitive Foundation of Effective Collaboration” 5<sup>th</sup> Annual ONR Conference on Collaborative Decision-Support Systems, Quantico, VA, September 11, 2003
- Other
  - Command Center Performance Assessment System, Evidence Based Research, April 2003
  - Government Executive “The Cognitive Path to Team Success.” (submitted)
  - Navy Institute Proceedings “Network Centric Teamwork” (in draft)
  - DTIC “Cognitive Basis of Collaboration” (in draft)



# Transitions

---

- Collaboration Diagnosis and Recommendation Tool
  - Currently used in EBR war room
  - Being evaluated by war room clients for internal use and by Collaborative Information Environment, JFCOM
  - To be demonstrated to Center for Naval Leadership, Little Creek
- Collaboration evaluation and evaluation metrics
  - Support to JFCOM experimentation
- Commercial book on cognitive basis of effective collaboration
  - Will follow publication path successfully employed by War Room book



# Summary

---

- A knowledge-centered theory can explain how collaboration works
- This theory informs collaboration performance metrics, guidelines for diagnosing collaboration problems, and methods for correcting collaboration problems
- Metrics documented and considered for use at JFCOM
- Five teams have tried out and used the Collaboration Advizor tool
  - Felt set of twelve cognitive enablers made sense
  - Said tool's diagnoses were accurate and helpful
  - Agreed tool helps by educating team members on important cognitive factors, by surfacing areas of agreement and disagreement, and by suggesting remedies
- Commercial version of tool to be completed this spring
- Transitions and publications on track